

UNITED STATES PATENT APPLICATION

of

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for

SLUDGE HARVESTER FOR REMOVING SLUDGE FROM SLUDGE PONDS

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SLUDGE HARVESTER FOR REMOVING SLUDGE FROM SLUDGE PONDS

BACKGROUND OF THE INVENTION

1. The Field of the Invention

[0001] The present invention relates generally to removal of organic-based wastes from sludge ponds. More specifically, the present invention relates to devices for removing sludge from sludge ponds, which sludge may then be directly applied to agricultural land, or used to produce organic fertilizers by processing the organic-based sludge.

2. The Relevant Technology

[0002] Feedlots, animal barns, municipal sewage, and farms that keep large numbers of animals are sources of enormous quantities of organic waste. The expression “organic waste source” will hereinafter refer to any of these sources of organic waste or to any source that similarly produces organic waste, although perhaps in different quantities or by different activities.

[0003] The disposal of untreated organic waste causes serious pollution problems which include those due to the waste’s high content of chemically oxidizable components and biochemically decomposable components. When these pollutants reach bodies of water, either because they leach from disposal sites or as a consequence of being directly released or transported into water bodies, they deoxygenate the receiving waters and impair the receiving waters’ capability to support aquatic life.

[0004] Acridity and high pathogen content present additional problems of untreated waste disposal. Acrid gases released into the atmosphere are not only unpleasant but they can also contribute to acid deposition, global greenhouse effects, and ozone depletion.

[0005] Organic waste that is left to run off into adjacent bodies of water or onto adjacent land is generally high in nitrogen and phosphorous, and has been linked to various dangerous toxic microorganisms.

[0006] In hog and cattle raising operations, water is typically used to flush waste out of barns and into storage facilities, thus producing a slurry that can be up to 97% liquid. The flushed waste is typically stored in earthen sludge ponds, sometimes referred to as lagoons. Most of the solids (including as much as 90% of the phosphates) settle as part of the sludge layer at the bottom of the pond. A large percentage of the nitrogen and potassium nutrients are entrained as soluble salts within the sludge layer. A relatively small percentage of these nutrients remains dissolved in the dilute layer, while some of the nitrogen also volatilizes into the atmosphere.

[0007] Sludge ponds have a limited useful life, and eventually must be cleaned out by removing the liquids along with the sludge layer. In addition, because of the high costs and environmental disadvantages of operating large sludge ponds, there has recently been increased pressure to use alternative treatment techniques that either require smaller lagoons or no lagoons at all.

[0008] In an attempt to recoup some of the cost of cleaning out such lagoons, methods and apparatus have been developed to retrieve some nutrient value of the organic waste, which can be used as a fertilizer. One method for retrieving some nutrient value of the organic waste in sludge ponds involves pumping the liquid out while agitating the sludge layer at pumping time to capture the nutrients that otherwise would remain behind in the lower settled layers. This slurry is then applied to agricultural land, often turning or knifing it into

the soil. Because the sludge layer is mixed with the liquid dilute layer, the retrieved mixture has a relatively low nutrient concentration.

[0009] Another method involves dredging the sludge layer, which is then air-dried and then applied to agricultural land. Dredges operate at relatively high flow rates (*e.g.*, 700-800 gpm). With current dredges and at these rates, there is a great deal of turbulence, vortexing, and mixing created between the sludge layer and the dilute layer, which results in column mixing of the layers. Mixing of these layers lowers the concentration of nutrients within the retrieved mixture.

[0010] In addition, each of these methods and apparatus involve relatively high equipment and operational costs. The cost of equipment and operation is often exacerbated because in many cases the animal raising operation is closing because of financial difficulties.

[0011] It would be an improvement in the art to provide a device and method that could be used to efficiently and inexpensively remove a high nutrient sludge product from sludge ponds, which sludge could then be either directly applied to agricultural land or used to produce a certifiable organic or other fertilizer.

BRIEF SUMMARY OF THE INVENTION

[0012] The present invention is directed to a sludge harvester for removing a concentrated nutrient sludge from sludge ponds. The harvester is intended to be relatively inexpensive from an equipment cost perspective, as well as relatively inexpensive to operate, while allowing the user to retrieve a high nutrient sludge product from sludge ponds so as to yield a valuable fertilizer product.

[0013] According to one embodiment, the sludge harvester comprises a frame, one or more wheels or skids attached to the frame, means for gently breaking up at least a portion of a sludge layer adjacent to a dilute layer, and means for capturing at least a portion of the broken up sludge layer.

[0014] The means for gently breaking up at least a portion of the sludge layer may comprise any mechanical device capable of gently breaking up a portion of the sludge layer. According to one embodiment, the means for gently breaking up at least a portion of the sludge layer comprises a pin mixer, an auger, or a rake. The means for gently breaking up a portion of the sludge layer is intended to just break up the surface of the sludge layer without overly agitating the material of the sludge layer with the adjacent liquid dilute layer. By keeping agitation to a minimum, the nutrient value of the recovered product is maintained at a high level.

[0015] The means for capturing at least a portion of the broken up sludge layer may comprise any mechanical device capable of capturing the concentrated nutrient layer. According to one embodiment, the means for capturing at least a portion of the broken up sludge layer may comprise a pump (e.g., a positive displacement pump). Because the sludge layer is gently broken up and over agitation is undesirable, the pump preferably removes the

sludge at a reduced rate as compared to alternative devices and techniques. According to one embodiment, the pump retrieves about 100 gallons per minute (gpm). For comparison sake, traditional dredging devices operate at about 800 gpm, resulting in greatly increased agitation. The increased agitation results in retrieval of a lower concentration of nutrients. In general, the pump will preferably retrieve about 200 gpm or less, more preferably about 150 gpm or less, and most preferably about 100 gpm or less.

[0016] According to one embodiment, the frame of the harvester includes a plurality of sideboards to further reduce turbulence and column mixing between the sludge layer and the dilute layer. Sideboards also substantially prevent vortexing of the dilute layer into the pump.

[0017] These and other benefits, advantages and features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In order that the manner in which the above recited and other benefits, advantages and features of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

[0019] Figure 1A is a perspective view of one embodiment of a sludge harvester according to the present invention;

[0020] Figure 1B is top view of the sludge harvester of Figure 1A;

[0021] Figures 2A and 2B are different perspective views of an alternative embodiment of a sludge harvester;

[0022] Figure 3 is a perspective view of the sludge harvester of Figures 1A-1B in operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

I. Introduction

[0023] A detailed description of the invention will now be provided with specific reference to figures illustrating preferred embodiments of the invention. It will be appreciated that like structures will be provided with like reference designations.

[0024] The present invention is directed to a sludge harvester for removing a concentrated nutrient sludge from sludge ponds. The harvester is intended to be relatively inexpensive to operate, while allowing the user to retrieve a high nutrient sludge product from sludge ponds so as to yield a valuable fertilizer product.

II. An Exemplary Sludge Harvester

[0025] Figures 1A and 1B illustrate an exemplary embodiment of a sludge harvester according to the present invention. The sludge harvester 100 includes a frame 102, a plurality of wheels 104, a pin mixer 106, and a pump 108, and a plurality of sideboards 110.

[0026] In the illustrated embodiment, the frame 102 comprises a flat bed, while the wheels 104, the pin mixer 106, and the pump 108 are attached to the frame 102. The flat bed 102 also includes a plurality of sideboards 110. The sideboards 110 provide a baffle that serves to prevent vortexing of the dilute layer into the pump 108. Reducing turbulence, vortexing, and over-agitation of the sludge layer and the adjacent dilute layer during operation of the pin mixer 106 and pump 108 allows recovery of a higher nutrient sludge product.

[0027] The means for gently breaking up at least a portion of the sludge layer may comprise any mechanical device capable of gently breaking up a portion of the sludge layer. The embodiment illustrated in Figures 1A and 1B includes a pin mixer 106, although other devices, for example, an auger or a rake could alternatively be used. The means for gently

breaking up a portion of the sludge layer is intended to just break up the surface of the sludge layer without overly agitating and mixing the material of the sludge layer with the adjacent liquid dilute layer. By keeping agitation and mixing to a minimum, the nutrient value recovered is maintained at a high level.

[0028] The means for capturing at least a portion of the broken up sludge layer may comprise any mechanical device capable of capturing a portion of the nutrient rich sludge layer. According to one embodiment, the means for capturing at least a portion of the broken up portion of the sludge layer may comprise pump 108 (*e.g.*, a positive displacement pump). Because the sludge layer is gently broken up and over agitation is undesirable, the pump preferably removes the material of the sludge layer at a reduced rate as compared to alternative devices and techniques. According to one embodiment, the pump operates from about 50-150 gpm, preferably about 200 gpm or less, more preferably about 150 gpm or less, and most preferably about 100 gpm or less. For comparison sake, many traditional dredging devices operate at about 800 gpm, resulting in greatly increased agitation and mixing between the sludge layer and the dilute layer. The reduced capture rate of the sludge harvester results in significantly lower agitation of the sludge and dilute layers. This allows retrieval of a sludge product having a higher concentration of nutrients.

[0029] The sludge harvester 100 may also include a tow rope, chain, or cable 112 which is attached to frame 102. The illustrated embodiment includes a tow cable 112 attached to each end of the sludge harvester 100. Each tow cable 112 can be attached to a winch or other device placed at each end of the sludge pond. In operation, the winch or other device may be operated to pull the sludge harvester across the sludge pond at a desired rate.

According to an alternative embodiment, the sludge harvester may be self-propelled, so as to include a motor.

[0030] Figures 2A-2B illustrate an alternative sludge harvester 200 including a frame 202, skids 204, a rake 206, and a pump 208 (Figure 2B). Sludge harvester 202 also includes sideboards 210 designed to reduce turbulence, vortexing, and mixing between the sludge layer and the dilute layer during operation. Rake 206 is an example of means for gently breaking up at least a portion of the sludge layer. Pump 208 is an example of means for capturing at least a portion of the broken sludge layer.

III. Exemplary Method of Use

[0031] Figure 3 illustrates the sludge harvester 100 in operation. The lagoon 300 includes a dilute layer 314 and a sludge layer 316. Although some nutrients are located in both layers, the vast majority of the nitrogen (N) potassium (K) and phosphates (P) are contained within the sludge layer 316. According to one embodiment, the sludge harvester 100 is operated in such a manner so as to capture a portion of the sludge layer without overly agitating the sludge layer and the dilute layer. The sludge harvester 100 accomplishes this by gently breaking up the sludge layer, rather than aggressively agitating and mixing both the sludge layer and the dilute layer. Operation in such a manner produces an organic sludge product having higher nutrient density than other techniques.

[0032] The sludge harvester 100 is introduced into lagoon 300. Because of the density of the sludge layer 316, the sludge harvester 100 will tend to sink at least partially into sludge layer 316.

[0033] A float 318 on the surface of lagoon 300 may be used to guide input and output lines 320 to the sludge harvester 100. For example, lines 320 may provide connections to the

sludge harvester 100 to provide air for the pump 108, exhaust from the pump 108, and organic sludge product delivery from the pump 108.

[0034] The organic sludge product retrieved by the sludge harvester 100 comprises a portion of the sludge layer 316. The organic sludge product may be applied directly as an organic fertilizer product to agricultural land, or the organic sludge product may be processed to produce a wet or dry organic fertilizer product.

[0035] It will also be appreciated that the present claimed invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative, not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.